Analysis of Reviews from Metaverse Platform Users Based on Topic Modeling

Jung Seung Lee*

Abstract

This study conducts an in-depth analysis of user reviews from three leading metaverse platforms - Minecraft, Roblox, and Zepeto - using advanced topic modeling techniques to uncover key factors for business success. By examining a substantial dataset of user feedback, we identified and categorized the main themes and concerns expressed by users.

Our analysis revealed that common issues across all platforms include technical functionality problems, user engagement and interest, payment concerns, and connection difficulties. Specifically, Minecraft users highlighted the importance of adventure and creativity, Roblox users expressed significant concerns about security and fraud, and Zepeto users focused heavily on the fairness of the in-game economy.

The findings suggest that for metaverse platforms to achieve sustained success, they must prioritize the resolution of technical issues, enhance features that foster user engagement, ensure reliable connectivity, and address platform-specific concerns such as security for Roblox and payment fairness for Zepeto.

These insights provide valuable guidance for developers and business strategists, emphasizing the need for robust technical infrastructure, engaging and diverse content, seamless user access, and transparent and fair economic systems. By addressing these key areas, metaverse platforms can improve user satisfaction, build a loyal user base, and secure long-term success in an increasingly competitive market.

Keywords : Metaverse, Topic Modeling, User Reviews, LDA (Latent Dirichlet Allocation), Platform Success Factors

1. Introduction

The concept of the metaverse has gained immense traction in recent years. This virtual realm allows users to engage in lifelike social interactions, transcending physical boundaries such as race, gender, or disabilities. The technological advancements in augmented reality, virtual reality, and mixed reality have significantly contributed to the evolution of the metaverse, providing users with an immersive and interactive experience that extends beyond the physical world [Lee et al., 2021].

The burgeoning metaverse industry presents a multitude of business opportunities and the potential for innovative business models. However, for these platforms to thrive, it is crucial to understand user experiences and expectations comprehensively. Analyzing user reviews offers invaluable insights into the factors that contribute to user satisfaction and dissatisfaction. Previous studies have highlighted that addressing user complaints and feedback is essential for preventing user attrition and enhancing user engagement [Kim et al., 2021]. Consequently, a systematic analysis of user reviews is imperative to identify the key factors that can drive the success of metaverse platforms.

This research aims to dissect and analyze user reviews from leading metaverse platforms to uncover the underlying themes and factors influencing user satisfaction and platform success. The study focuses on three highly popular metaverse platforms: Minecraft, Roblox, and Zepeto. These platforms were selected due to their substantial user base and the extensive availability of review data, making them ideal candidates for a detailed analysis. The primary objectives of this research are to identify key themes and topics, understand user satisfaction and dissatisfaction, and provide actionable insights for platform developers and business strategists.

By systematically analyzing user reviews, this research seeks to provide a deeper understanding of user experiences and expectations within the metaverse. The insights gained from this study are intended to inform the development of more user-centric metaverse platforms, ultimately contributing to their long-term success and sustainability.

2. Related Research

2.1 Metaverse

The importance of metaverse research lies in its ability to inform the development of platforms that enhance user experience and engagement. By understanding how users interact within these virtual spaces, developers can create more intuitive and satisfying environments. For instance, Dechant et al. [2021] highlighted the significance of avatar personalization in promoting sustained user engagement, demonstrating that users are more likely to continue using a platform if they can customize their digital representations.

Studies have identified several success factors for metaverse platforms. Wang and Ahn [2024] emphasized the importance of providing enjoyable experiences, ensuring continuous connectivity, and fostering creativity as key drivers of user immersion and sustained use. Jo [2023] conducted a comparative analysis of various metaverse platforms, revealing commonalities and differences that provide valuable insights for platform developers. These studies suggest that a successful metaverse platform must prioritize user sat-

isfaction, technical stability, and innovative content to thrive in the competitive digital landscape.

Understanding the complex nature of the metaverse is essential for anticipating its future impact on society and leveraging its potential. As research progresses, it will offer critical insights that inform the creation of more engaging, user-centric metaverse platforms. This will contribute to the platforms' long-term sccess and support the broader digital transformation of social and economic landscapes.

2.2 Text Mining-Based Metaverse Analysis

Text mining has become an essential tool for analyzing large volumes of unstructured data, such as user reviews and social media posts, which can provide valuable insights into user experiences and preferences. In the context of the metaverse, text mining techniques have been employed to analyze user feedback and understand the various factors that contribute to the success or failure of virtual platforms. This section will detail studies that utilize different text mining methods, including TF-IDF, topic modeling, Word2Vec, and Transformer models.

In the realm of metaverse research, Kim and Kim [2023] employed TF-IDF to analyze news articles and user reviews related to various metaverse platforms. By applying TF-IDF, they were able to extract the most relevant terms and identify emerging trends in user preferences and technological advancements. This study highlighted the growing interest in immersive experiences and the importance of social interactions within virtual environments. The findings provided insights into user expectations and the evolving landscape

of metaverse platforms, guiding developers to focus on enhancing social features and interactive content.

An et al. [2022] utilized LDA to analyze user reviews from the metaverse platform Zepeto. By applying topic modeling, they identified the main themes and issues discussed by users, such as avatar customization, social interactions, and technical difficulties. This research provided a deeper understanding of user priorities and pain points, which are crucial for improving user satisfaction and engagement. The study concluded that enhancing avatar customization options and addressing technical issues should be prioritized to retain and attract users.

Hong et al. [2019] applied Word2Vec to analyze user reviews of mobile augmented reality applications, including those related to the metaverse. By creating word embeddings, they identified relationships between different aspects of user experience, such as ease of use, enjoyment, and technical performance. This approach revealed that positive user experiences were strongly associated with intuitive interfaces and engaging content, while negative reviews often mentioned technical issues and usability problems. The insights from this study suggested that developers should focus on creating user-friendly interfaces and minimizing technical glitches to improve user satisfaction.

In a recent study, Lee et al. [2023] utilized BERT to perform sentiment analysis on user reviews from various metaverse platforms. By analyzing the sentiment expressed in the reviews, they were able to categorize user feedback into positive, negative, and neutral sentiments. This analysis provided a comprehensive view of user satisfaction and dissatisfaction, highlighting areas where platforms

excel and where they need improvement. For example, positive sentiments were often associated with immersive experiences and social connectivity, while negative sentiments frequently mentioned technical issues and security concerns. The study recommended that metaverse platforms invest in robust technical infrastructure and security measures to enhance user trust and satisfaction.

3. Methodology

3.1 Data Collection and Preprocessing

This study focuses on analyzing user reviews from three prominent metaverse platforms: Minecraft, Roblox, and Zepeto. The data collection process involved scraping user reviews from the Google Play Store using Python 3.8 and the Selenium library. The period for data collection spanned from December 2019 to February 2022, ensuring a substantial and relevant dataset that captures user experiences and sentiments over time.

We targeted reviews with detailed feedback to capture a comprehensive range of user experiences and sentiments. Approximately 10,000 reviews were collected for each platform, resulting in a robust dataset for analysis. The collected reviews then underwent a thorough preprocessing phase to ensure the data was clean, relevant, and suitable for text mining techniques.

The preprocessing phase involved several key steps. The first step was to remove irrelevant data that could interfere with the analysis. This included filtering out advertisements, non-informative text, and duplicate reviews. By eliminating these extraneous elements, we ensured that the dataset contained only meaningful user feedback.

Using the 'konlpy' library's 'Okt' function, we tokenized the text. Tokenization involves breaking down the reviews into individual words and phrases, making the text easier to analyze. We also removed stopwords, which are common words that do not contribute significant meaning to the analysis, such as conjunctions and prepositions. Additionally, terms that frequently appeared but were irrelevant to the analysis, such as the names of the platforms, were filtered out.

To ensure consistency across the dataset, all text was converted to lowercase. This step also involved standardizing spelling variations and abbreviations. By normalizing the text, we reduced the risk of treating different forms of the same word as distinct entities.
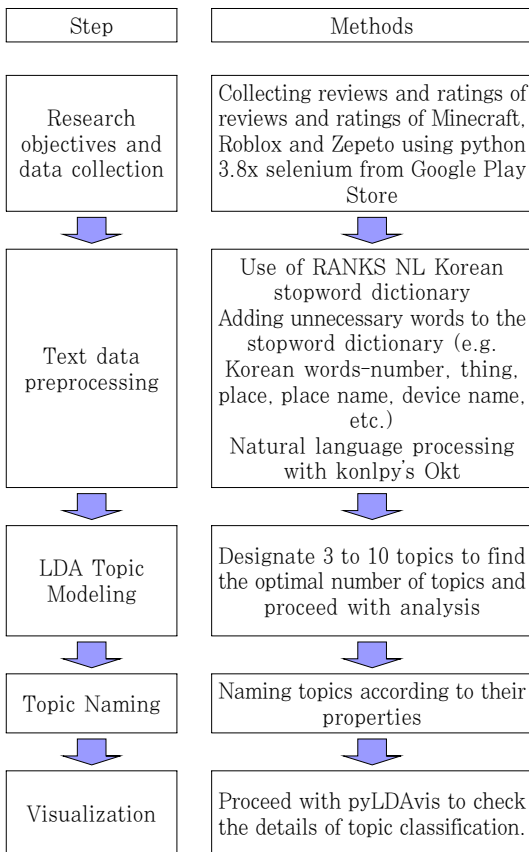
Lemmatization was applied to reduce words to their base or root form. This process helps in grouping similar terms together, which captures the true meaning of the text and improves the accuracy of the analysis. For example, words like "running" and "ran" would be reduced to their lemma, "run."

By meticulously preprocessing the data, we ensured that our text mining techniques would yield accurate and meaningful results. This comprehensive preprocessing phase was crucial in preparing the dataset for subsequent analysis, allowing us to extract valuable insights into user experiences and preferences across the three metaverse platforms.

3.2 Topic Modeling Analysis Procedure

In this study, we employed Latent Dirichlet Allocation (LDA) to uncover hidden topics within the user reviews from Minecraft, Roblox, and Zepeto. LDA is a powerful topic modeling technique that identifies clusters of words that frequently occur together, reveal-

ing the underlying themes within a large set of documents. The following steps detail the procedure used for our topic modeling analysis as shown in ⟨Figure 1⟩.

Step	Methods
Research objectives and data collection	Collecting reviews and ratings of reviews and ratings of Minecraft, Roblox and Zepeto using python 3.8x selenium from Google Play Store
Text data preprocessing	Use of RANKS NL Korean stopword dictionary Adding unnecessary words to the stopword dictionary (e.g. Korean words-number, thing, place, place name, device name, etc.) Natural language processing with konlpy's Okt
LDA Topic Modeling	Designate 3 to 10 topics to find the optimal number of topics and proceed with analysis
Topic Naming	Naming topics according to their properties
Visualization	Proceed with pyLDAvis to check the details of topic classification.

⟨Figure 1⟩ Research Steps and Methods

After preprocessing, the reviews were transformed into a structured format suitable for LDA analysis. This involved creating a document-term matrix where each review is represented as a vector of word counts. This matrix serves as the foundation for the LDA algorithm to identify patterns and relationships between words across different reviews.

We implemented the LDA model using the 'gensim' library. To determine the optimal number of topics, we experimented with vari-

ous topic counts ranging from three to ten. The coherence score, which measures the semantic similarity of words within a topic, was used to evaluate the performance of each model. We found that a model with four topics provided the best balance between interpretability and granularity.

Each topic generated by the LDA model was analyzed to determine its most significant terms. These terms were used to infer the main theme of each topic. This step involved a detailed examination of the terms to ensure that the assigned topic names accurately reflected the underlying themes.

To enhance our understanding and interpretation of the results, we utilized 'pyLDAvis', a sophisticated visualization tool that provides an interactive exploration of the topics. In this visualization, each topic is represented as a circle, with the size of the circle indicating the prevalence of the topic across the corpus. The distance between the circles signifies the similarity between topics. The right panel displays the top terms for each selected topic, providing a clear overview of the most important words within that topic.

4. Analysis Results

4.1 Analysis Results of Minecraft Platform Reviews

The topic modeling analysis for Minecraft user reviews yielded four distinct topics, each representing key themes derived from user feedback. The topics were identified and named based on the most significant terms within each topic, as shown in ⟨Table 1⟩. The topics identified are 'Functionality error,' 'Adventure,' 'Interest,' and 'Connection Complaints.'

〈Table 1〉 Topics and Relative Terms in Minecraft Platform

Topics	Top-4 most relative terms for each topic	Estimated term frequency within the selected topic
1 (Function error)	Install	0.045
	Skin	0.024
	Fix	0.023
	Update	0.022
2 (Adventure)	Game	0.052
	Construct	0.016
	Fun	0.012
	Wild	0.011
3 (Interest)	Interesting	0.073
	Bug	0.034
	Game	0.029
	Friend	0.023
4 (Connecton complaints)	Log in	0.131
	Error	0.046
	Refund	0.035
	Account	0.023

The first topic, "Functionality Issues," was characterized by terms such as "install," "skin," "fix," and "update." These terms indicate user concerns related to the technical performance and stability of the game. Users frequently mentioned problems with installing the game, issues with skins, the need for fixes, and the importance of updates. This topic reflects the technical challenges and bugs that players encounter, which can significantly affect their gaming experience.

The second topic, "Adventure," included terms like "game," "construct," "fun," and "wild." These terms highlight the aspects of Minecraft that revolve around exploration and creativity. Users often described their experiences with building structures, enjoying the fun and freedom the game offers, and engaging in wild, adventurous activities. This topic captures the core gameplay elements that make Minecraft appealing to its user base.

The third topic, "Interest," was identified by terms such as "interesting," "bug," "game," and "friend." This topic focuses on the general interest and engagement that users have with Minecraft. Positive terms like "interesting" and "friend" suggest that users find the game engaging and enjoy playing with friends. However, the presence of the term "bug" also indicates that while users are interested, they still encounter technical issues that can detract from their overall experience.

The fourth topic, "Connection Complaints," was dominated by terms such as "log in," "error," "refund," and "account." This topic centers on user difficulties related to logging in, encountering errors, issues with refunds, and account management problems. Connection and access issues are critical as they directly impact a user's ability to play the game. The frequency and prominence of these terms suggest that these issues are a significant source of frustration for users.

Among the four topics, "Functionality Issues" and "Connection Complaints" stand out as critical areas of concern. Both topics highlight technical and accessibility issues that can severely impact the user experience. "Functionality Issues" focuses more on the in-game technical problems, while "Connection Complaints" deals with issues related to accessing and maintaining user accounts.

"Adventure" and "Interest" are more positive topics, reflecting the core enjoyable aspects of Minecraft. "Adventure" specifically captures the creativity and exploration elements, which are central to the game's appeal. "Interest" indicates overall user engagement and social aspects, such as playing with friends.

4.2 Analysis Results of Roblox Platform Reviews

The topic modeling analysis for Roblox user reviews yielded four distinct topics, each highlighting significant themes from user feedback. The topics identified and named based on the most prominent terms within each topic, as shown in ⟨Table 2⟩, are "Function Errors," "Security," "Interest," and "Game Features."

⟨Table 2⟩ Topics and Relative Terms in Roblox Platform

Topics	Top-4 most relative terms for each topic	Estimated term frequency within the selected topic
1 (Function error)	Bug	0.045
	Fix	0.024
	Server	0.023
	Screen	0.022
2 (Security)	Person	0.052
	Declaration	0.016
	Game	0.012
	Fraud	0.011
3 (Interest)	Interesting	0.073
	Friend	0.034
	Exceed	0.029
	Adopt	0.023
4 (Game Features)	Game	0.131
	Interesting	0.046
	Pay cash	0.035
	Various	0.023

The first topic, "Function Errors," is characterized by terms such as "bug," "fix," "server," and "screen." These terms indicate user frustrations with various technical issues encountered while using the platform. Users frequently mentioned bugs that needed fixing, server-related problems, and screen glitches. This topic reflects the technical difficulties and instability issues that players experience, which can significantly affect their overall enjoyment and satisfaction with the platform.

The second topic, "Security," includes terms like "person," "declaration," "game," and "fraud." These terms suggest concerns related to the safety and security of the platform. Users discussed issues such as reporting other players, concerns about in-game fraud, and overall security within the game. This topic underscores the importance of maintaining a secure environment where users feel safe from scams and inappropriate behavior.

The third topic, "Interest," is defined by terms such as "interesting," "friend," "exceed," and "adopt." This topic focuses on the aspects of Roblox that users find engaging and enjoyable. Positive terms like "interesting" and "friend" suggest that users are highly engaged with the platform, enjoying the social interactions and creative possibilities. The term "adopt" likely refers to popular in-game activities such as adopting virtual pets, which adds to the game's appeal.

The fourth topic, "Game Features," includes terms like "game," "interesting," "pay cash," and "various." This topic highlights the diverse features of Roblox that attract users. The term "interesting" reappears, reinforcing the engagement users feel. The mention of "pay cash" indicates discussions around in-game purchases, while "various" reflects the wide range of games and activities available on the platform. This topic captures the multifaceted nature of Roblox, from its variety of games to the monetization aspects.

Among the four topics, "Function Errors" and "Security" are critical areas of concern that need immediate attention. "Function Errors" focus on the technical issues within the game that can disrupt the user experience, while

"Security" deals with users' concerns about the safety and integrity of the platform.

"Interest" and "Game Features" highlight the positive aspects that keep users engaged. "Interest" focuses on the social and creative elements, suggesting that users find significant enjoyment in interacting with friends and engaging in creative activities. "Game Features" reflect the diversity and richness of the Roblox platform, which are key to its appeal.

4.3 Analysis Results of Zepeto Platform Reviews

The topic modeling analysis for Zepeto user reviews identified four distinct topics, each representing significant themes derived from user feedback. These topics, as shown in 〈Table 3〉, are "Connection Complaints," "Payment," "Interest," and "Functionality Errors."

〈Table 3〉 Topics and Relative Terms in Zepeto Platform

Topics	Top-4 most relative terms for each topic	Estimated term frequency within the selected topic
1 (Connection complaints)	Account	0.029
	Log in	0.019
	Install	0.018
	Delete	0.011
2 (Payment)	Coin	0.035
	Pay cash	0.035
	Get	0.031
	Game	0.023
3 (Interest)	Interesting	0.033
	Game	0.033
	TikTok	0.032
	Character	0.028
4 (Function error)	Error	0.025
	Fix	0.023
	Advertisement	0.017
	Game	0.015

The first topic, "Connection Complaints," is characterized by terms such as "account," "log in," "install," and "delete." These terms indicate user difficulties related to accessing and maintaining their accounts. Users frequently mentioned problems with logging in, issues during installation, and the need to delete and reinstall the app due to errors. This topic highlights significant accessibility issues that can prevent users from engaging with the platform, leading to frustration and potentially deterring continued use.

The second topic, "Payment," includes terms like "coin," "pay cash," "get," and "game." These terms reflect user concerns and discussions around the in-game currency and payment system. Users often discussed the challenges of obtaining coins, the necessity of spending real money to progress or enhance their experience, and the overall in-game economy. This topic underscores the importance of a fair and transparent payment system to ensure user satisfaction and retention.

The third topic, "Interest," is defined by terms such as "interesting," "game," "TikTok," and "character." This topic focuses on the aspects of Zepeto that users find engaging and enjoyable. The term "TikTok" suggests that users enjoy creating and sharing content on other social media platforms, while "character" indicates that avatar customization is a significant draw. This topic captures the creative and social elements that make Zepeto appealing to its user base.

The fourth topic, "Functionality Errors," includes terms like "error," "fix," "advertisement," and "game." These terms indicate various technical issues users encounter, including errors that need fixing and problems related to advertisements interrupting gameplay. This topic reflects the technical challenges that can

disrupt the user experience and indicates areas where the platform needs improvement.

Among the four topics, "Connection Complaints" and "Functionality Errors" are critical areas that require immediate attention. "Connection Complaints" focus on the accessibility issues that prevent users from logging in and maintaining their accounts, which can significantly impact user retention. "Functionality Errors" highlight the technical problems that disrupt the overall user experience, such as bugs and intrusive advertisements.

On the other hand, "Interest" and "Payment" highlight the aspects that keep users engaged and satisfied. "Interest" reflects the social and creative elements, indicating that users enjoy customizing their avatars and sharing content on platforms like TikTok. "Payment" discusses the in-game economy, suggesting that a transparent and fair payment system is crucial for maintaining user satisfaction.

5. Conclusion and Business Implications

5.1 Conclusion

This study conducted a comprehensive analysis of user reviews from three prominent metaverse platforms: Minecraft, Roblox, and Zepeto, using topic modeling techniques. The analysis identified key themes and issues highlighted by users, providing valuable insights into their experiences and satisfaction levels. The primary topics identified across the platforms included functionality issues, user interest and engagement, payment concerns, and connection complaints.

When comparing the analysis results across the three platforms, several common themes and notable differences emerged.

All three platforms exhibited significant user concerns regarding technical problems such as bugs, errors, and overall stability. These issues were a major source of dissatisfaction, highlighting the importance of a robust and reliable technical infrastructure. Each platform had a topic related to user interest and engagement, indicating that users find creative and social aspects highly appealing. Whether it is adventure in Minecraft, diverse game features in Roblox, or social media integration in Zepeto, maintaining high levels of engagement is crucial. Accessibility issues, such as difficulties in logging in or maintaining connections, were prevalent across the platforms. Ensuring seamless access and reliable connectivity is essential for retaining users.

The topics for Minecraft were "Functionality Issues," "Adventure," "Interest," and "Connection Complaints." The emphasis on "Adventure" underscores Minecraft's unique appeal through exploration and creativity. Roblox's topics included "Function Errors," "Security," "Interest," and "Game Features." The presence of a distinct "Security" topic highlights user concerns about safety and fraud, which is more pronounced in Roblox compared to the other platforms. For Zepeto, the topics were "Connection Complaints," "Payment," "Interest," and "Functionality Errors." The "Payment" topic reflects significant user discussions around in-game currency and the fairness of the payment system, which was less emphasized in the other two platforms.

5.2 Business Implications

Based on the analysis results, several considerations are crucial for the success of each platform.

The first, all platforms must prioritize re-

solving technical problems to enhance user satisfaction. Regular updates and thorough testing can help mitigate bugs and errors, providing a smoother user experience. Ensuring that these issues are minimized will greatly improve user satisfaction and retention.

The second, maintaining and expanding the features that keep users engaged is essential. For Minecraft, this means continuing to develop adventure and creative modes. Roblox should focus on diverse game features and ensure a safe environment. Zepeto should enhance social integration and avatar customization to keep users interested. By focusing on these engagement drivers, platforms can maintain a loyal user base and attract new users.

The third, ensuring seamless access and reliable connections is critical. Platforms should invest in robust server infrastructure and optimize login processes to reduce connection-related frustrations. Addressing these issues will ensure that users can easily access and enjoy the platform without interruption.

The fourth, Roblox needs to address security concerns by implementing stricter measures against fraud and providing clear reporting mechanisms. Ensuring a secure environment will build user trust and loyalty. Users need to feel safe and secure while interacting on the platform, which will encourage continued use and engagement.

The fifth, Zepeto should focus on creating a fair and transparent payment system. Ensuring users feel that the in-game economy is balanced and accessible without excessive spending will improve user satisfaction. Providing clear information and fair opportunities for all users to earn or purchase in-game items will foster a positive user experience.

In conclusion, while each platform has unique strengths and areas for improvement, addressing common issues such as functionality and connectivity, while also focusing on platform-specific concerns like security and payment systems, will be vital for their continued success and user retention in the competitive metaverse market. By taking these considerations into account, metaverse platforms can enhance their user experience, build a loyal user base, and achieve long-term success.

References

[1] An, J. Y., Shim, S. Y., and Yun, H. J., "Metaverse augmented reality research trends using topic modeling methodology", Knowledge Management Research (KMR), Vol. 23, No. 2, 2022, pp. 123-142.

[2] Dechant, M. J., Birk, M. V., Shiban, Y., Schnell, K., and Mandryk, R. L., "How avatar customization affects fear in a game-based digital exposure task for social anxiety", Proceedings of the ACM on Human-Computer Interaction, 2021, pp. 1-27.

[3] Hong, J. L., Yu, M. R., and Choi, B. R., "An analysis of mobile augmented reality app reviews using topic modeling",, Journal of Digital Contents Society, Vol. 20, No. 7, 2019, pp. 1417-1427.

[4] Jo, H., "Tourism in the digital frontier: A study on user continuance intention in the metaverse", Information Technology & Tourism, Vol. 25, No. 3, 2023, pp. 307-330.

[5] Kim, E. J. and Kim, J. Y., "Exploring the online news trends of the metaverse in south korea: A data-mining-driven semantic network analysis", Sustainabil-

ity, Vol. 15, No. 23, 2023, 16279.

〔6〕 Kim, S. H., Chang, N. S., and Kim, K. W., "Academic trend analysis of shared economy based on text mining and network analysis", Journal of the Korean Entrepreneurship Socieity, Vol. 16, No. 2, 2021, pp. 15-34.

〔7〕 Lee, H., Jung, H. S., Lee, S. H., and Kim, J. H., "Robust sentiment classification of metaverse services using a pre-trained Language Model with soft voting", KSII Transactions on Internet and Information Systems (TIIS), Vol. 17, No. 9, 2023, pp. 2334-2347.

〔8〕 Lee, L. H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., and Hui, P., "All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda", arXiv preprint arXiv:2110.053 52, 2021.

〔9〕 Wang, S. and Ahn, S., "Exploring user behavior based on metaverse: A modeling study of user experience factors", Proceedings of International Conference on Human-Computer Interaction(Cham), Springer Nature Switzerland, pp. 99-118.

■ Author Profile

Jung Seung Lee

He is currently working as an associate professor at the School of Business of Hoseo University, and serves as a director of the Korea Intelligent Information Systems Society. He received his bachelor's and master's degrees from the Department of Management Science at KAIST, and his Ph.D. in management engineering from the same graduate school's Business School. He founded SNS site, Old Boy (oldboy.co.kr), financial consulting site, Best Money (bestmoney.co.kr), blockchain-based personal history authentication solution (Career Ledger) company, Smart-I Co., Ltd. His main interests are Smart Factory, Smart Grid and Sustainable Supply Chain.